Highlights

- Cobrinhos is a new open-air Middle Palaeolithic site associated with the Tejo River terrace staircase
- For being in a colluvial context, it is impossible to date directly
- Combination of archaeology and geo-disciplines allow deducing reliable ages at ca. 165 - 155 ka
- Variety of artefacts, sizes and many small artefacts show context reliability
- Lithic analysis confirm coherent Mousterian assemblage

Geoarchaeology of the Cobrinhos site (Vila Velha de Ródão, Portugal) - a record of the earliest Mousterian in western Iberia

Telmo Pereira[1*], Pedro P. Cunha[2], António A. Martins[3], David Nora[1], Eduardo Paixão[1,4], Olívia Figueiredo[5], Luis Raposo[6], Francisco Henriques[5], João Caninas[5], Delminda Moura[7], David R. Bridgland[8]

[1] ICArEHB – Interdisciplinary Center for Archaeology and Evolution of Human Behaviour, Faculdade de Ciências Humanas e Sociais, Universidade do Algarve, PORTUGAL;

Telmo Pereira: telmojrpereira@gmail.com (corresponding author);

David Nora: david.ac.nora@gmail.com

[2] MARE – Marine and Environmental Sciences Centre; Department of Earth Sciences, University of Coimbra; PORTUGAL; pcunha@dct.uc.pt

[3] ICT – Instituto de Ciências da Terra, Departamento de Geociências, Universidade de Évora, Rua Romão Ramalho, 59, 7000-671 Évora, PORTUGAL; aam@uevora.pt

[4] Laboratory for Traceology and Controlled Experiments (TraCEr), MONREPOS – Archaeological Research Centre and Museum for Human Behavioural Evolution. RGZM. GERMANY; paixao@rgzm.de

[5] EMERITA – Empresa Portuguesa de Arqueologia, Uni. Lda, Apartado 32 – BEC Oeiras, 2781-901 Oeiras PORTUGAL; Caninas: emerita.portugal@gmail.com; Olívia Figueiredo: oliviaffigueiredo@gmail.com; Francisco Henriques: fjrhenriq@gmail.com

[6] MNA – Museu Nacional de Arqueologia, Praça do Império. 1400-206 Lisboa, PORTUGAL; 3raposos@sapo.pt

[7] CIMA – Centro de Investigação Marinha e Ambiental, Faculdade de Ciências e Tecnologia, Universidade do Algarve, Campus Gambelas 8005-139 Faro PORTUGAL; dmoura@ualg.pt

[8] Department of Geography, Durham University, South Road, Durham DH1 3LE, UK; d.r.bridgland@durham.ac.uk

Abstract

Cobrinhos (Vila Velha do Ródão, central eastern Portugal) is a Mousterian site found during factory construction in 2014. This area is located in the Lower Tejo valley, which is characterized in terms of geomorphology by six river terraces, numbered downwards (T1 to T6), with Palaeolithic industries associated only with T4 to T6. Terrace T4 was recently dated as spanning ca. 340 ka to 155 ka, with Acheulean in the basal and middle levels and early Mousterian in the uppermost levels. The geological context at Cobrinhos is a colluvial unit that links to the top of T4. It has evidence for palaeoweathering with the same characteristics as seen in T1 to T4, considerably different from that seen in T5 and T6. Despite disturbance by ploughing, the site shows a uniform distribution of sizes and shapes of lithic artefacts, with thousands of implements <30 mm and a coherent Mousterian assemblage including Levallois and discoidal reduction pieces, Levallois flakes, blades and points, pseudo-Levallois points, notches, denticulates, sidescrapers, and an absence of Acheulean or Upper Palaeolithic tools. The available data suggest that the colluvial unit is coeval with the topmost T4 deposits and that the Cobrinhos industry is in its original geomorphological context. Although the colluvial unit cannot be dated directly, from the combination of site data and available published luminescence ages for T4, we suggest a probable age of ca. 165 to 155 ka for this industry. These results are of relevance in the investigation of the demise of archaic Pleistocene human populations and the proliferation of Neanderthal groups in Iberia.

Keywords: Mousterian; Middle Palaeolithic; Neanderthals; fluvial terraces; River Tejo; Iberian Peninsula.

1. Introduction

1.1. The Middle Palaeolithic in western Eurasia

The Middle Palaeolithic of Iberia has received considerable attention in recent times in connection with the extinction of the Neanderthals (e.g. Zilhão 2009, 1993, 2000, 2006; Jöris et al. 2003; Finlayson et al. 2006, 2008, Zilhão et al. 2010, 2017; Bradtmöller et al. 2012; De la Peña 2013; Galván et al. 2014; Bicho et al. 2015), but is also relevant in connection with the early establishment of the Mousterian, the diversity and demise of early archaic human forms and the widespread distribution of the first Neanderthals (Álvarez-Alonso, 2014; Daura et al., 2017; Ollé et al., 2013; Santonja et al., 2016; Santonja and Pérez-González, 2006; Terradillos-Bernal and Díez-Fernández-Lomana, 2012).

The beginning of the Middle Palaeolithic in western Eurasia corresponds, in general terms, to a gradual (but not linear) replacement of handaxes and cleavers by pre-determined blank production, especially Levallois (Boëda, 1994, 1993; Boëda et al., 1990; Bordes, 1980, 1971, 1961, 1953; Bourguignon, 1997; Dibble and Bar-Yosef, 1995; McPherron, 1994; Mourre, 2003; Tixier et al., 1980). Early evidence of changes towards the Middle Palaeolithic appears through western Europe back to Marine Isotope Stage (MIS) 11 (424 to 374 ka; Lisiecki and Raymo 2005), but unequivocal Levallois occurs only during MIS 9 (337 to 300 ka) and the MIS 9-8 transition (Adler et al., 2014; Álvarez-Alonso, 2014; Bridgland et al., 2013; Bridgland and White, 2014; Carmignani et al., 2017; de la Torre et al., 2013; Picin et al., 2013; Santonja et al., 2016; Schreve et al., 2002; Soriano and Villa, 2017; Westaway et al., 2006; White et al., 2006).

We believe that the first Neanderthal populations in Iberia immigrated via the Pyrenees. The earliest evidence of Middle Palaeolithic comes from eastern Spain, namely from Atapuerca TD10, dated between 400 and 300 ka (Berger et al., 2008; Falguères et al., 1999; Fernández Peris et al., 2008; Ollé et al., 2013; Rodríguez, 2004). No evidence of handaxes was found but sidescrapers, denticulates and Levallois artefacts were found, dating from 347-242 ka (Fernández Peris et al., 2008). The main rivers of the region must have worked as preferential pathways of penetration and dispersal, the Tejo/Tajo

(Tagus in English) possibly being one of the most useful due to its length and width and as it crosses Iberia from the east to the western Atlantic coast. As a result, it passes through different geographic settings and landscapes, which may have favoured the creation of ecological niches with abundant and diverse resources capable of supporting long-term human occupation, even during periods with the harshest and coldest conditions (Dennell et al., 2011; González-Sampériz et al., 2010; Rodrigues et al., 2011; Voelker et al., 2017).

In the Spanish sector of the Middle River Tejo, the first evidence of Mousterian occurs in the middle deposits of terrace T19, alongside Acheulean, but the Acheulean disappears in the upper deposits (Laplana et al., 2015; Panera et al., 2011a, 2011b, Silva et al., 2017, 2013). Mousterian without Acheulean also occurs within the sequences of T20 and T21 (Arsuaga Ferreras and Aguirre Enríquez, 1979; Panera et al., 2014; Rubio-Jara et al., 2016; Silva, 2003; Yravedra et al., 2012). In Portugal, the record is patchy; however, recent investigation in the Lower Tejo proved that the river terrace staircases there are important archives for the interpretation of human occupation during the Pleistocene, including the record of the Lower to Middle Palaeolithic transition that occurs within the sediments of the T4 terrace, probably at ca. 220 ka (Cunha et al., 2017b, 2017a, 2016a).

1.2. Previous research on the Palaeolithic in the Lower Tejo

In the Lower Tejo, investigation focused on the identification of lithic industries began in the 19th century, leading to the identification of Lower Palaeolithic to Mesolithic sites (Cartailhac, 1886; Choffat, 1884; Corrêa, 1928, 1926; Costa, 1865; Delgado, 1901; Ribeiro, 1867, 1866, 1880, 1873b, 1873a, 1871). Near the coast, Furninha and Moura caves revealed Pleistocene lithic artefacts, fauna and human remains (Delgado, 1884, 1867). Between the 1930s and 1960s, the production of the 1/50,000 Portuguese geological maps allowed the identification of multiple sites, some with stratigraphy

(Zbyszewski and Breuil 1943; Zbyszewski 1943, 1946, 1954, 1958, 1966, 1977; Breuil and Zbyszewski 1945; Raposo and Cardoso 2000; Cunha et al. 2017a), while the National Archaeological Museum team excavated many Upper Palaeolithic sites in the flint-rich region of Rio Maior (Heleno, 1965; Zilhão, 1997). From the 1970s to the 1980s, the construction of the Fratel dam led to the discovery of rock art and Palaeolithic sites in stratigraphical setting in the Ródão area (Lower Tejo reach I), some with excellent preservation conditions, namely at Monte Famaco (Raposo, 1996; Raposo et al., 1993; Silva et al., 1975), Vilas Ruivas (G.E.P.P., 1983, 1980, Raposo and Silva, 1982, 1981) and Foz do Enxarrique (G.E.P.P., 1977; Raposo et al., 1985; Raposo and Brugal, 1999). Later, mandatory Cultural Resources Management (CRM) activity, related to construction projects, exposed Mousterian sites in the Lower Tejo at Estrada do Prado (Mateus, 1984), Santa Cita (Bicho and Ferring, Reid, 2001; Lussu et al., 2001), Conceição (Raposo and Cardoso, 1998) and Campo de Futebol de Santo Antão do Tojal (Figueiredo et al., 2005). From the 1990s onwards, investigation at the right-bank margin of the Lower Tejo has revealed Pleistocene contexts, especially in the long-timescale sequence at the Ribeira da Atalaia site (e.g. Grimaldi and Rosina, 2001).

In Columbeira, Suão and Salemas caves, all located in the western face of the nearby Estremenho Limestone Massif (>130 km towards the west) and discovered during the exploitation of quarrying, were found rich lithic Mousterian assemblages along with fauna and, at Columbeira, Pleistocene human remains (Ferreira, 1966, 1984; Roche, 1973; Roche et al., 1962, 1961; Roche and Veiga Ferreira, 1970; Zbyszewski et al., 1961). From the 1980s onwards, the Caldeirão cave (Zilhão, 1997, 1992), the Almonda karst system (Zilhão et al., 1993, 1990) and Picareiro cave (Bicho et al., 2000) yielded Palaeolithic data, including abundant fauna and human remains.

In summary, the concentration of Palaeolithic sites in the Lower Tejo basin and nearby areas (e.g. the Estremenho Limestone Massif), particularly in the relatively small area of Ródão, provides scope for geomorphological and sedimentological studies, absolute dating of the deposits, and stone-tool analysis, enabling the integration of data obtained from the sedimentary records with archaeological data. This combination supports the reconstruction of local palaeoclimate, palaeoenvironment, palaeolandscape and stone-tool characteristics, with a view to shedding light on human behaviour.

The aim of this paper is to present results of the geomorphological, sedimentological and archaeological investigations carried out at Cobrinhos, in order to provide an improved understanding of the Middle Palaeolithic human occupation and resource exploitation here, as well as environmental conditions during the Middle to Late Pleistocene of westernmost Iberia.

1.3. The Lower Tejo terraces

River terrace systems are amongst the best archives for the reconstruction of Pleistocene palaeoclimate, palaeoenvironment and palaeolandscape, as well as human behaviour (Bridgland and Westaway, 2008; Bridgland, 2000; Bridgland and Maddy, 2002; Chauhan et al., 2017; Daveau, 1993, 1980; Martins et al., 2017; Martins and Cunha, 2009; Mishra et al., 2007). The sedimentary records of the Tejo allow the geological evolution of this river to be traced back to ca. 4 Ma (Cunha, 1996, 1992, Cunha et al., 2017b, 2016a, 1993, Cunha and Martins, 2004, 2000; Martins et al., 2009; Martins and Cunha, 2009; Silva et al., 2017) and provide a large number of archaeological sites in the Spanish (High and Middle Tajo) and Portuguese (Lower Tejo) sectors (e.g. Santonja and Villa, 1990; Raposo et al., 1993; Raposo, 1995; Raposo and Santonja, 1995; Santonja and Pérez-González, 2010).

The uppermost reach of the Lower Tejo (Portuguese Reach I) coincides with the Vila Velha de Ródão – Feia/Remédios and Arneiro – Vilas Ruivas depressions. The stratigraphic units that record the evolution of the Lower Tejo have different sedimentary characteristics and lithic industries (e.g. Cunha et al. 2016). The oldest geological bedrock units comprise the Neoproterozoic and Lower Cambrian schists and metagreywackes of the Beiras Group (e.g. Romão 2001) and the Ordovician Armorican Quartzite Formation (Metodiev et al. 2009; Lobarinhas et al. 2010). The latter forms resistant ridges that topographically dominate the very extensive adjacent planation surface. The Cenozoic is represented by the Cabeço do Infante, Silveirinha dos Figos and Falagueira formations, all with predominant soft sandstones and gravels (Cunha 1992, 1996). The Late Pliocene and Pleistocene record is summarized as follows (Cunha et al., 2012): (i) a culminant sedimentary unit, termed USB13, with an age of 4–1.8 Ma and corresponding with ancestral River Tejo sediments that cap the Cenozoic basin-fill, laid down shortly before the drainage network started to become entrenched, without artefacts; (ii) T1 (ca. 1000? - 900 ka), without artefacts; (iii) T2 (top deposits ca. 600 ka), without artefacts; (iv) T3 (ca. 460 - 360? ka), without artefacts; (v) T4 (ca. 340 - 155 ka), with Acheulean in the basal and middle levels and Mousterian in the uppermost levels; (vi) T5 terrace (135 - 73 ka), with Mousterian throughout the sequence; (vii) T6 terrace (62 - 32 ka), also with Mousterian throughout the sequence; (viii) Carregueira Sands (aeolian sands) (32 to 12 ka), with Upper Palaeolithic to Epi-Palaeolithic; (xix) the floodplain (ca. 12 ka to Holocene), with Mesolithic and more recent industries.

In general, the terrace deposits are composed of massive clast-supported boulder gravels of sub-rounded to rounded quartzite (≥75%) pebbles, poorly to moderately sorted and packed out by a coarse sand to silt quartz matrix. The T5 and T6 terraces have upper parts comprising sandy-silts, ca. 4 to 5 m-thick. At Foz do Enxarrique, the T6 terrace has some thin levels of pedogenic calcareous concretions and a bed containing faunal remains (e.g. Cunha et al., 2008) (Fig. 1, Fig 2; Supplementary Information 1: Table 1).

1.4. The Cobrinhos site

The Cobrinhos site is located close to the northern margin of Lower Tejo Reach I, in the left side of the confluence area of the Enxarrique stream, a minor right-bank tributary of the Tejo, this location being immediately upstream of the Portas do Ródão ridges, at Vila Velha de Ródão (Fig. 3a and 3b). The site was found in the autumn of 2014, during work related to the enlargement of a factory (Henriques, 2015). Although the developer performed all the mandatory procedures, the site was not detected by any archaeological work (Albergaria, 2014; Carvalho, 2014; Jacinto, 2008a, 2008b). It was only during westward enlargement of the original building that a high concentration of Mousterian stone tools was recognized, scatted on the surface (Henriques, 2015) (Fig. 3c).

Preliminary results showed that (1) stone-tools were concentrated in an area of ca. 1600 m^2, corresponding with a superficial shallow layer between 15 and 40 cm that was heavily disturbed by ploughing down to a maximum depth of 40 cm, (2) the assemblage was congruent with the Mousterian, with discoidal and Levallois production, (3) there were large numbers of flakes <3 cm, all homogeneously slightly patinated, and (4) artefacts typical of the Lower or Upper Palaeolithic were absent. Based on this, we concluded that, despite the absence of an “archaeological Pompeii” scenario, (1) the assemblage was well delimited in area and depth, (2) it was rich, culturally homogeneous and with considerable technological integrity and, therefore, (3) it promised a significant contribution to the characterization of the Middle Palaeolithic.

2. Materials and methods

The development in which the Cobrinhos site was found occurred during the Portuguese economic crisis and this circumstance deeply affected the procedures, as the village is one of the poorest of the country. Under rainy conditions, a team of five people undertook a reconnaissance of the area, recording thickness, cultural evidence, chronology, preservation, relevance and undertaking necessary additional works in five days.

The information presented is derived from geomorphological, stratigraphical, sedimentological and archaeological data collected from the study area and using a standard geoarchaeological fieldwork approach: geomorphological survey and generation of a detailed map using GIS, followed by field description of the sedimentary deposits. Since the archaeological layer was identified as a Pleistocene colluvial unit resulting from the degradation of the T3 terrace, most of the geological data were obtained from primary field observations (geomorphological, stratigraphical and sedimentological). In addition, sediment samples were collected for sedimentological analyses (texture and composition); samples were not collected for luminescence dating, because complete bleaching before deposition could not be guaranteed.

2.1 Field methods

For horizontal control, an alphanumeric grid of 10x10 m was established, covering 3500 m^2. To verify the existence of small implements a 1 m radius around each intersection of the grid was subjected to surface collection. For stratigraphical control, a trench 45 m long x 2 m wide x 2.5-1 m deep was mechanically excavated to expose the sequence down to the bedrock; in addition, another stratigraphical profile was exposed by the construction activity (Fig. 3d and 4a to 4c). Since the entire surface was covered with lithic artefacts and rock debris (Fig. 5a), four manual test pits were excavated (Test pit 1 – 2x1m adjacent to the trench was obliterated by rain; Test pit 2= 2 x 1 m, Test pit 3 x 3 m; Test pit 4 2 x 2 m) to observe any layers that may occur with discreet sedimentary differences that could not be recognized during the mechanical work (Fig. 5b to 5d). The sediments from these test pits were wet-sieved using a 5 mm mesh and samples were taken for laboratory analysis.

Since it was impossible to perform a manual excavation of the entire area and unacceptable to discard the major volume of sediment with archaeological remains, it was agreed to excavate the archaeological layer mechanically in the richest 1600 m^2, using a toothless bucket to ensure a cleaner cut, and following the grid. The sediments were transported to an adjacent area, square by square. Each truck carried a sheet with the alphanumeric code of each square and the sediments were deposited separately. After this, the entire area was bulldozed for the construction. Four people, using two 2 x 1 m stainless steel screens with 15 mm mesh, wet-sieved all the sediments over a period of three months. The mesh size was chosen due to the predominant gravel component. Finally, 10 litres of <15 mm gravel was sampled from the screened sediments of each square to recover and estimate the total number of chips (Paixão et al., 2016; Pereira et al., 2015a, 2015c).

Given the disturbance and of the shallow deposit we did not collect samples for pollen and other micro-residues as these are likely to have been contaminated by modern elements and it was unlikely that they could preserve elements with relevance for reconstructing the palaeoenvironment.

2.2 Sedimentary analysis

Due to the quantity and size of the clasts, and the overall conditions 'under which the fieldwork was carried out these were described in the field in terms of the rock type and general sphericity. Six sedimentary samples of 6 l each (Layer 1, Layer 2, Layer 3, top, Layer 3 base, Layer 4 – colluvial unit – and Layer 5 – substratum; Cabeço do Infante Formation) were collected for determination of clay-mineral composition in order to understand the genesis of the deposit and the palaeoenvironment associated with its formation. These were the most important aspects of site fomation to be understood, as they would provide knowledge of whether the artefacts were transported from somewhere else or if they were in their original geomorphological position.

The sediment samples arrived wet at the Centre for Marine and Environmental Research – CIMA, University of Algarve. Samples were thinly spread on brown paper sheets and described macroscopically. Then they were quartered twice to ensure randomness for the collection of subsamples for freeze-drying at room temperature to dehydrate them without using a kiln, in order to avoid chemical alteration. Since each sample had numerous clay aggregates, they were disaggregated mechanically in a ball mill. Then the <63 μm fraction was sent to the Department of Earth Sciences of the University of Coimbra (Laboratory of Sedimentology) for determination of the clay-mineral composition.

The mineralogical composition of the sand fraction was estimated by observation using a Wild mod. Heerbrugg 84220 stereoscopic binocular microscope (50x). The mineralogical composition of the <2 μm fraction was obtained by X-ray diffraction of oriented samples, before and after treatment with ethylene glycol and heating to 550°C. A Philips PW 3710 X-ray diffractometer was used, with a Cu tube, at 40 KV and 20 nÅ, and the software APD 3.6J-Automatic Powder Diffraction (Philips). The percentages of clay minerals in each sample were determined through the peak areas of the mineral present, with the use of specific correction parameters.

2.3 Analysis of lithic artefacts

The archaeological assemblage from Cobrinhos was studied following standard technological (Benito del Rey and Benito Álvarez, 1998; Boëda, 1994, 1993; Boëda et al., 1990; Bourguignon, 1997; Mourre, 2003; Tixier et al., 1980) and typological criteria (Bordes, 1961). Retouch was only considered when patina was congruent with the rest of the artefact. The data were input in an Access file using the E4 interface (http://www.oldstoneage.com/software/e4.shtml).

The Cobrinhos assemblage is composed solely of lithic artefacts. To avoid misinterpretation, only implements showing clear evidence of knapping were collected. Fire-cracking was searched for but not found. The total inventory is 15,779 specimens but, for the purpose of characterizing the site, 16 squares were sampled, which provided a total of 5543 artefacts, corresponding to 35.1 % of the total. An extensive study of the entire assemblage will be presented elsewhere in the near future.

3. Results

3.1. Characterization of the colluvial unit

The Cobrinhos colluvial unit is at an altitude of 130-120 m that links, towards the south, to the N4 erosive surface (a "glacis"/ramp at an altitude of 120 to 109 m) that correspondingly links to the surface of the T4 terrace (Fig. 6).

The colluvial unit overlies, with an erosive contact (discordance), the Cabeço do Infante Formation, which is >20 m-thick and has a greyish yellow colour (Munsell 2.5 y6.2). The colluvium is 15 to 75 cm thick, is composed of sub-angular quartzite (~75-80%) pebbles and cobbles and milky quartz (~20-25%) pebbles, and has the following stratigraphic sequence (from top to base):

- Layer 1: 15-25 cm-thick. Present in the entire area. Ploughed. Sandy-silt matrix, reddish brown colour when wet (Munsell 7.5yr3.4). High clay component, leading the sediment to be plastic and easily moulded when wet. Some clay agglomerates have small stems and fossil roots in a light coloured sandy matrix (deferruginized). Some clay agglomerates have concentrations of iron oxides in their cores. The layer is dominated by a poorly sorted gravel of sub-angular quartzite pebbles and cobbles, but also, in much less quantity, milky quartz pebbles. Organic material varies between dark carbonaceous particles and readily identifiable plant remains. Abundant Mousterian artefacts, which are slightly patinated.

- Layer 2: 20 to 30 cm-thick. Does not occur in the western sector of the study area.

Ploughed. Plastic clay agglomerates more common towards the bottom. Presence of small plant elements. Sandy-silt matrix highly rich in iron oxides with dull reddish brown colour (Munsell 2.5yr4.4). Poorly sorted quartzite (predominant) and quartz gravel of sub-angular clasts. Abundant Mousterian artefacts, slightly patinated.

- Layer 3: 20 cm to 1 m-thick, depending on location. Silt-clay matrix, dark reddish brown colour (Munsell 2.5 yr 3.4). Poorly sorted gravel, containing sub-angular clasts of quartzite (predominant) and quartz. It has small nodules of plastic white clay. Lacks archaeological material.

- Layer 4: 15 cm thick. Poorly sorted gravel, comprising sub-angular clasts of quartzite (predominant) and quartz. Silt-clay matrix, with greyish red colour (Munsell 2.5 yr 6.2). Some intraclasts of whitish arkose, from the Palaeogene substratum, can be found. Lacks archaeological material.

- Layer 5: Bedrock. Cabeço do Infante Formation.

The mineralogical composition of the <2 μm fraction, obtained by XRD, indicates that Layer 1, Layer 2 and Layer 3 top have similar proportions of smectite, ilite and kaolinite. Layer 3 base and Layer 4 do not have smectite and have similar values of ilite and kaolinite, while Layer 5 (Cabeço do Infante Formation) is almost exclusively composed of smectite (Table 1 and Supplementary Information 2). That is, smectite is predominant in the substratum, but the colluvial unit layers are dominated by the association of ilite and kaolinite. The Palaeoweathering that affects this old colluvial unit, i.e., rubification due to the presence of goethite and a clay mineral association of illite and kaolinite, is identical to that typical of the higher terraces, indicating a warm temperate climate with very strong seasonal contrast. This means that the colluvial unit was fed by a deposit located in a higher position on the slope (the T3 terrace) and not by the erosion of the Cabeço do Infante Formation that is underlying it.

3.2. Archaeological assemblage

Within a total area of ca. 48,000 m^2, the archaeological finds (Fig. 7) were concentrated in about ca. 1600 m^2. The assemblage was clearly congruent with Mousterian, there being no artefacts typical of any other period: the implements were only slightly patinated and there was a large abundance of artefacts <3 cm as well as implements of several tens of centimeters, suggesting a good preservation of the site despite the obvious disturbance.

The raw material of the lithic assemblage is dominated by quartzite (91.1 %), of which 8.1 % is a black fine-grained variety, along with milky quartz (8.8 %) and other local rocks (0.05 %) Many artefacts are coated with red clay, this often being almost impossible to remove.

Flakes are the most common artefacts (60 %), followed by chips (28.0 %) and fragments (12.3 %); preparation and maintenance products make up to 1.6 %. Blades (1%) and points (0.3 %) occur only in small numbers (Table 2).

Cores have been made on pebbles (84 %) and flakes (11.3 %). The reduction strategies are discoidal (21.6 %), informal (18.3 %), Levallois recurrent (15.5 %), centripetal (11.7 %), chopper/chopping-tool (11.3 %), prismatic (9.9 %), Levallois preferential (8.4 %) and polyhedral (3.3 %). Most cores were abandoned without evident reason (67.1 %) but others were abandoned due to loss of volume (15.5 %), knapping defects (13.1 %) or raw material problems (4.2 %) (Fig. 8). The morphology of the nodules is sub-rounded to rounded, with thin and poorly developed cortex (Supplementary Information 1: Table 2).

Blanks are mostly complete (75.9 %). The paucity of mesial fractions may be related to the difficulty in recognizing these in the context. Cortex is absent in 64.9 % of the blanks and 16.5 % have <30 %. In the blanks, cortex is located on one side laterally (26.5 %), distally (24.2 %) or on one side and on the distal (20.0 %) or proximal (17.6 %) ends.

Sections are triangular (36.2 %), plain (29.0 %), trapezoidal (15.6 %) and irregular (15.5 %). Their shapes are irregular (35.1 %) biconvex (20.0 %), concave-convex (19.2 %) or divergent (13.6 %). Profiles are mostly straight (80.5 %). Dorsal patterns are typically unidirectional (33.8 %), crossed (32-0 %) and centripetal (10.8 %). Distal ends are stepped (29.5 %), feathered (29.0 %) or hinged (20.7 %), while platforms are plain (50.1 %), dihedral (13.2 %), faceted (12.7 %) or cortical (11.6 %) (Supplementary Information 2: Table 2). The blank: core ratio is 9.3 and, despite some larger artefacts, the general blank assemblage comprises implements with dimensions 20-50 x 20-45 x 8-15 mm (Fig. 9). Kombewa cores and flakes are also present in small numbers and with small dimensions (Table 2 and Supplementary Information 1: Table 3).

The tool assemblage is composed of sidescrapers (24.1 %), Levallois blanks (23.6 %), retouched flakes (13.8 %), denticulates (11.6 %), pseudo-Levallois points (10.5 %) and notches (9.4 %). There is no artefact typical of the Acheulean or of any subdivision of the Upper Palaeolithic (Table 3).

4. Discussion

4.1 The geological context of the Cobrinhos assemblage

By integrating archaeological, geomorphological and sedimentological data it is possible to explain the formation of the context at Cobrinhos. Despite it being clearly ploughed, this combination of data offers crucial clues about the formation processes of the site. The assemblage was limited in area and thickness, with a wide range of sizes, including chips. There is an absence of local memory about land use other than growing olive trees, so it is possible that the human occupation level(s) were buried and protected until ploughing in 2014, which may have displaced the lithic artefacts throughout the upper ca. 40 cm (which is the range of the plough). It would otherwise be expected that the site would have been found previously by any research team working in Ródão during the last 40 years or by the Cultural Research Management teams working for the factory project. If previously exposed, it would also be expected that the assemblage would show some sorting, but the only signal in the lithic material is from the patina, which is congruent with water percolation, a normal trait considering the shallow context and the open-air setting. Finally, the implements have a wide range of sizes and shapes and all phases of reduction sequences are represented. The only elements that are under-represented are implements < 1.5 cm (very small flakes and chips), due to the excavation conditions. Indeed, the uneven distribution of the artefacts on the surface and with no concentration towards the slope may suggest they could be just a few tens of cm from their original position (Supplementary information 1: Table 4).

In contrast with other sites where water-worn pebbles were the preferential raw material for knapping, the Cobrinhos assemblage was made on material derived directly from the erosion of the massive quartzite outcrops that dominate the study area and spread angular quartzite material across the landscape, which does not, therefore, have a well-developed cortex. This is the cause of the overall low frequency of cortex. The low blank-to-core ratio contrasts with the intensive reduction of some cores, which suggests that blanks were exported, implying that the site functioned as a quarry, which is also the impression that arises from its overall setting. Nevertheless, the occurrence of complete Levallois blanks and the diversity of tools suggest that it might have had other purposes, such as hunting and/or butchery. Since the site sits over a dense quartzite gravel, the retouched tools must have been intended products, probably related to specific human activities, and not the result of 'Distance Decay' (Renfrew, 2001) or Frison effect (Dibble, 1987), as these are related to the increase of retouch with curation of raw materials and artefacts with increasing distance from raw material sources. Unfortunately, the non-preservation of faunal remains prevents corroboration of these inferences. In summary, the lithic assemblage is fully consistent with a Mousterian industry without any Acheulean influence or Upper Palaeolithic contamination and, therefore, its age must be younger than the closing of Aroeira cave (ca. 280 ka) and older than the earliest Upper Palaeolithic (ca. 35-32 ka).

The large number of lithic artefacts does not fit with interpretation as a single/short occupation, as documented at other Mousterian sites (Vilas Ruivas, in the study area; Praia Rei Cortiço and Mira Nascente, on the western central Portuguese coast), but probably represents multiple occupations. Despite the conditions under which it was found and excavated, Cobrinhos does not differ significantly from any other European open-air Palaeolithic site on the surface of a Pleistocene terrace with readily available fluvial bedload material of lithologies suitable for stone-tool production. (Chlachula and Chlachula, 2014). In fact, because the assemblage does not come from surface collection but from extensive wet-sieved sediments, it is not significantly biased (only for implements <15 mm) and, therefore, it is a reliable case study for the Mousterian. However, more detailed presentation of the lithic assemblage is necessary to improve knowledge of the technological processes.

As previously observed, the ancient colluvial unit at Cobrinhos, with its associated Mousterian industry, is developed at an altitude of 130-120 m and links with a ramp (a “glacis”, the N4 valley-edge surface) that connects with the T4 terrace at Ródão (at 120 m altitude). This deposit has the same sediment and weathering characteristics as the top of the T4 sequence and differs from T5 and T6, implying that the environment in which it was formed must pre-date ca. 135 ka. This geomorphological setting implies that, despite the difficulty of getting reliable absolute dates for the archaeological deposit, the Cobrinhos industry probably has an age congruent with the topmost deposits of the T4 terrace: at least 155 ka and probably ≥170 ka. Based on this, the possible age range is ca. 200-155 ka and the most probable age is between ca. 165 and 155 ka.

Since Pleistocene human remains from Portugal can be directly related with lithic industries, with earlier Middle Pleistocene human forms occurring with Acheulean, Neanderthals with Mousterian and modern humans with Upper Palaeolithic (Daura et al., 2017; Duarte et al., 2002; Trinkaus et al., 2011, 2003, 2001; Trinkaus and Maki, 2007; Trinkaus and Zilhão, 2002), the implication is that Cobrinhos represents a Neanderthal occupation.

The abundance of Mousterian sites in the Lower Tejo suggests that it was an attractive location, potentially with better conditions for occupation than other regions (Dennell et al., 2011; González-Sampériz et al., 2010; Rodrigues et al., 2011; Voelker et al., 2017). It may also have worked as a preferential pathway between different landscapes. Unfortunately, detailed comparison between sites, especially in connection with sources of raw material, the technology and typology of the lithic assemblages and the geomorphological and stratigraphical setting, is very difficult because most have never been studied in detail. For the few that have, the comparison is still very difficult because approaches were very different according to the protocols used by different teams.

4.2. The Middle Palaeolithic in westernmost Iberia

In central Portugal, evidence from the Aroeira cave indicates that the Mousterian was not yet established by ca. 280 ka (Daura et al., 2018; Hoffmann et al., 2013) or by ca. 201 ka (Cunha et al., 2017b). Typical Mousterian occurs throughout the sequence of Oliveira Cave but along with larger blanks, cleavers and handaxes until ca. 91-61 ka (Deschamps and Zilhão, 2018; Hoffmann et al., 2013; Richter et al., 2014; Zilhão et al., 2013), which is congruent with the material from Milharós, from a colluvial unit above T4 sediments (Raposo, 1996; Raposo et al., 1993), including exquisite handaxes, dated as younger than 155 ka (Cunha et al., 2017b; Raposo, 1996; Raposo et al., 1993). Other sites in the Lower Tejo indicate that Mousterian without Acheulean influence was already established when the uppermost deposits of T4 were formed. This is documented by the Atalaia football field site (≥170 ka) (Martins et al., 2010b) and Pegos do Tejo 2 (>135 ka) (Almeida et al., 2007). In this last case, a patinated handaxe was reused, as is shown by the presence of retouch cutting the patinated surface (Almeida

2014).

Typical Mousterian without Acheulean or Upper Palaeolithic influence, that is, Levallois and discoidal technology with centripetal and knapped pebbles, Levallois and pseudo-Levallois blanks, notches, denticulates and sidescrapers, occurs at many terrace sites of the Lower River Tejo with ages similar to or younger than the base of T5 (135 ka) and the sequence of T6 (younger than 32 ka). These include Caminho da Celulose (Cunha et al., 2008; G.E.P.P., 1977), Vilas Ruivas (Cunha et al., 2008; Raposo, 1995), Ribeira da Atalaia -T5 top (Cura, 2014; Rosa, 2013; Rosina et al., 2014), Estrada do Prado (Mateus, 1984), Santa Cita (Bicho and Ferring, Reid, 2001; Lussu et al., 2001), Conceição (Raposo and Cardoso, 1998) and Santo Antão do Tojal (Cunha et al., 2017b; Raposo, 1995), Campo de Futebol de Santo Antão do Tojal (Figueiredo et al., 2005), Azinhal and Tapada do Montinho (Almeida, 2014, 2013; Almeida et al., 2007; Cunha et al., 2017b, 2017a, 2016b), and Foz do Enxarrique (Berruti et al., 2016; Cardoso, 1993; Cunha et al., 2008; Martins et al., 2010a; Raposo, 1995; Raposo et al., 1985; Raposo and Brugal, 1999).

The coastal sedimentary sequences of western central Portugal, particularly at Praia Rei Cortiço (ca. 101 ka) and Mira Nascente (ca. 40 ka) (Benedetti et al., 2009; Cabral et al., 2018; Haws et al., 2009), also contain Mousterian without Acheulean or Upper Palaeolithic influence. This is the same pattern as found in caves such as Columbeira (Cardoso et al., 2002; Pereira et al., 2015b), possibly dating from between ca. 101 ka and 39 ka (Zilhão et al., 2011), Caldeirão (>31 ka) (Zilhão, 1997, 1993, 1992), Escoural (ca. 49 ka) (Zilhão and D ’Errico, 2000), Figueira Brava (ca. 45 to 31 ka) (Antunes, 1992; Cardoso and Raposo, 1995). A single handaxe was found in Furninha cave at the base of the succession, although it does not seem to be related to the upper Mousterian levels (Bicho and Cardoso, 2010; Breuil and Zbyszewski, 1945; Cardoso, 1993; Delgado, 1884). There are reports of other sites with smaller assemblages and/or a need for further detailed description, such as Salemas (ca. 32 ka) (Antunes et al., 1989; Raposo, 1995).

5. Conclusions

Despite the recent anthropogenic disturbance of the site, the following can be summarized about Cobrinhos: (1) The assemblage is not pristine but it is in its original geomorphological/geological context, which corresponds with a valley-margin colluvial unit; (2) the colluvial unit (resulting from the degradation of the T3 terrace) and associated artefacts are coeval with the deposition of the uppermost deposits of the T4 terrace (with a possible age range of ca. 200-155 ka and most probable age between ca. 165 and 155 ka); (3) the assemblage has internal coherence and is consistent with a Mousterian industry without Acheulean influence. The large number of artefacts and the depth of distribution suggest that multiple occupations are represented.

Data from Reach I of the Lower Tejo thus indicate that Acheulean was still present at Milharós at 201 ka but Middle Palaeolithic industries, and coeval occupation by Neanderthals, were already established by ca. 200-165 ka, with full Mousterian technology and without Acheulean influence. This industry persisted in the study area until ca. 34 ka. The Upper Palaeolithic is only encountered after 32 ka, in association with a cover unit of aeolian sands.

Considering the ages for both the Acheulean and the Mousterian, the probable age of the Lower to Middle Palaeolithic transition in westernmost Iberia (Portugal) is here proposed as between ca. 200 and 180 ka, although this needs to be supported by improved geochronology.

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Table 1: Mineral identification in the <2um fraction of the studied samples. S - Smectite; I - Illite; K - Kaolinite.

Sampled level	Smectite	Illite	Kaolinite	Clay Association
Layer 1	37%	45%	18%	I S k
Layer 2	57%	30%	13%	S I k
Layer 3 top	47%	32%	21%	S I k
Layer 3 base	0%	47%	53%	K I
Layer 4	0%	66%	34%	I k
Layer 5	89%	4%	7%	S k i

Table 2: Cobrinhos. General inventory.

Technological category/Raw material		Other	Quartzite	Black quartzite	Quartz	Total
Blocks	Pebbles		1			1
	Nodule		2			2
Debitage	Cores		193	15	5	213
	Flake	3	2431	346	46	2826
	Blade		50	3		53
	Point		13	2		15
Maintenance	Cornices		12	1		13
	Crest		6			6
	Debordant		18	3		21
	Flank		11	3		14
	Core front		42	4	1	47
Debris	Fragment		592	61	27	680
	Core Fragment		82	10	6	98
	Chip		1149	1	404	1554
	Total	**3**	**4602**	**449**	**489**	**5543**

Table 3: Cobrinhos. Tool-type list.

Type/Raw material	Greywacke	Quartzite	Black quartzite	Quartz	Flint	Total
1 Typical Levallois flake		27	6			33
2 Atypical Levallois flake		38	6			44
3 Levallois point		4	1			5
4 Retouched Levallois point		1				1
5 Pseudo-Levallois point		32	5			37
6 Mousterian point		2				2
8 Limace	1					1
9 Single straight sidescraper		9	3			12
10 Single convexe sidescraper		26	6			32
11 Single concave sidescraper		10	1			11
12 Double straight sidescraper		2				2
13 Double straight-convex sidescraper		4				4
15 Double biconvex sidescraper		1				1

16 Double biconcave sidescraper –		1				1
17 Double concave-convex sidescraper		3	1			4
21 Déjeté sidescraper		1				1
22 Transverse straight sidescrapers		4	4			8
23 Transverse convex sidescrapers		3	1			4
25 Plain face sidescrapper		1	1			2
26 Abrupt sidescraper		2	2			4
29 Sidescraper with alternate retouch		1	1			2
34 Typical perforator		1	1		1	3
36 Backed Knife		2				2
38 Natural Backed Knife		9	3			12
39 Mousterian Raclette		1				1
40 Mousterian tranchet			2			2
41 Truncation		7				7
42 Notch		27	1	1		29
43 Denticulate		35	5			40
45 Flake with ventral retouch		31	1	1		33
46 Thick Flake with abrupt retouch		4	1			5
47 Thick Flake with alternate retouch		2				2
48 Thin Flake with abrupt retouch		4				4
49 Thin Flake with alternate retouch		2				2
54 Distally notch		3	2			5
56.Rabot		1				1
61.Chopping-tool		7				7
Total	**1**	**308**	**54**	**2**	**1**	**366**

Figure caption:

Figure 1: Geomorphological map of Lower Tejo Reach I (Vila Velha de Ródão area): 1 – quartzite ridge; 2 – erosion level correlative of the T1; 3 – T1; 4 – T2; 5 – T3; 6 – erosion level correlative of the T3; 7 –T4; 8 – erosion level correlative of the T4; 9 – T5; 10 – erosion level correlative of the T5; 11 – T6; 12 – alluvium; 13 – colluvial unit; 14 – Ponsul fault; 15 – archaeological sites; 16 – altitude (m). Palaeolithic sites 1 – Cobrinhos; 2 – Foz do Enxarrique; 3 – Monte do Famaco; 4 – Monte da Revelada; 5 – Vilas Ruivas; 6 – Tapada do Montinho; 7 – Pegos do Tejo; 8 – Arneiro.

Figure 2: Diagram with the River Tejo terrace system at Vila Velha de Ródão. 1- Metamorphic basement; 2- Cabeço do Infante Formation; 3- T1 terrace; 4- T2 terrace; 5- T3 terrace; 6- T4 terrace; 7- T5 terrace; 8- T6 terrace; 9- Aeolian sands; 10- Sedimentary river bed; 11- Tejo River.

Figure 3: Cobrinhos location a) in the Iberian Peninsula and in the basin of the River Tejo; b) In Lower Tejo reach I; c) In relation to the factory before being amplified towards west; d) Concentration area of artefacts (red) manual test pits (green) and trench (white).

Figure 4: Cobrinhos profiles: a) trench; b) cut made by the construction works; c) Geological log with along with a detail of a section of the trench.

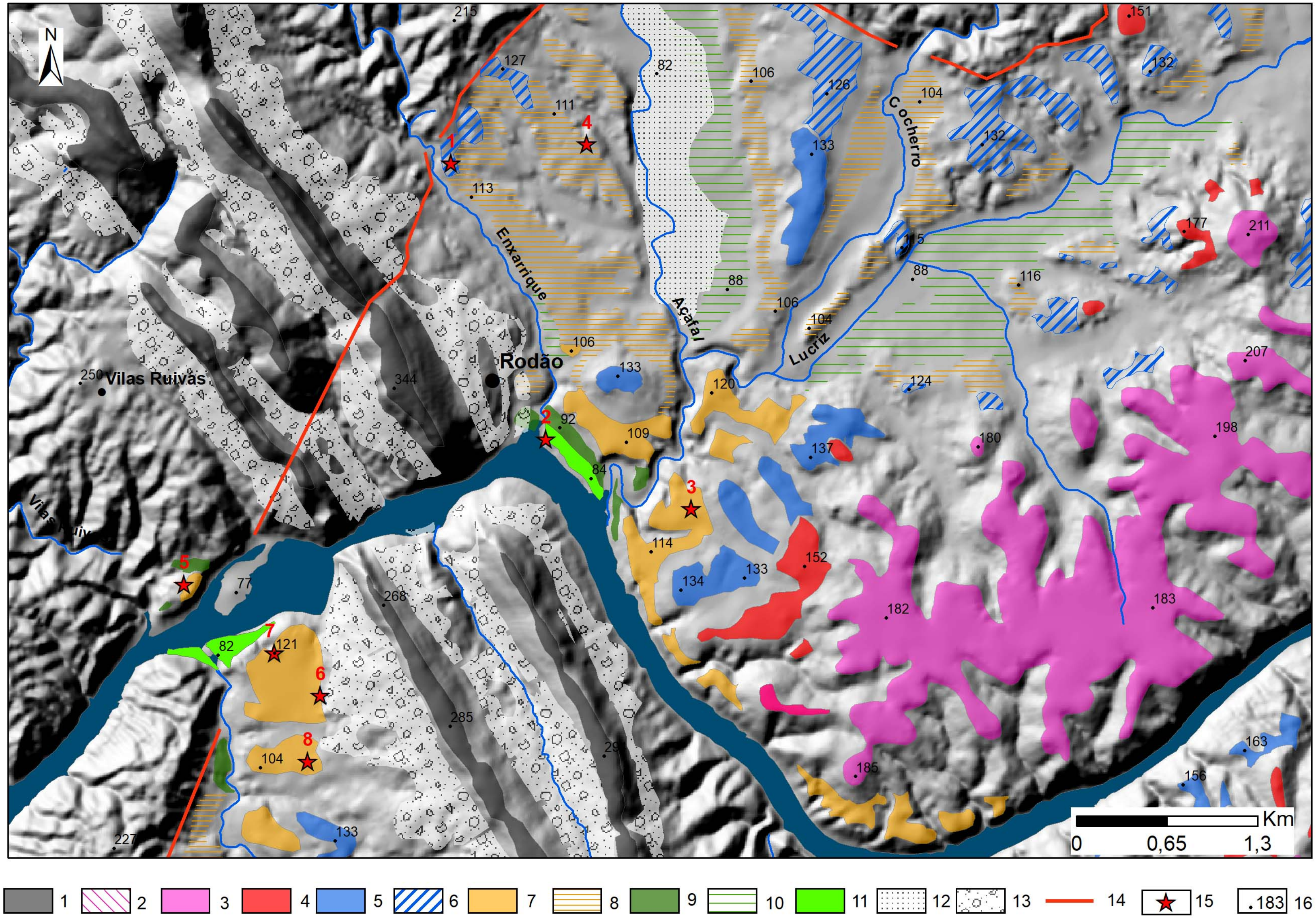
Figure 5: Cobrinhos. Archaeological context with the natural layers. a) Surface; b) test pit 2; c) test pit 3; d) test pit 4. Test pit 2 was obliterated due to the rain.

Figure 6: Cobrinhos. Profile made using GPS-RTK showing schists and metagreywackes (Lower Cambrian) bedrock, Cabeço do Infante Formation (Paleogene), the N4 erosion surface, the colluvial unit (Pleistocene) and Cobrinhos site.

Figure 7: Cobrinhos. Lithic assemblage. *Levallois* recurrent, Levallois preferential, discoidal, centripetal, Kombewa cores, *Levallois* flakes, pseudo-*Levallois* points, denticulates, notches and side scrappers.

Figure 8: Cobrinhos. Complete blanks. a) Plot of length and width of the complete blanks; b) box and jitter plot of length, width and thickness in millimetre.

Figure 9: Cobrinhos. Complete cores. a) Length and width of the complete cores; b) box and jitter plot of length, width and thickness in millimetre. C – Centripetal; Ch – Chopper/Chopping-tool; D – Discoidal; I – Informal; K – Kombewa; LP – *Levallois* preferential; LR – Levallois recurrent; P – Polyhedral; Pr – Prismatic.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84
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250
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114
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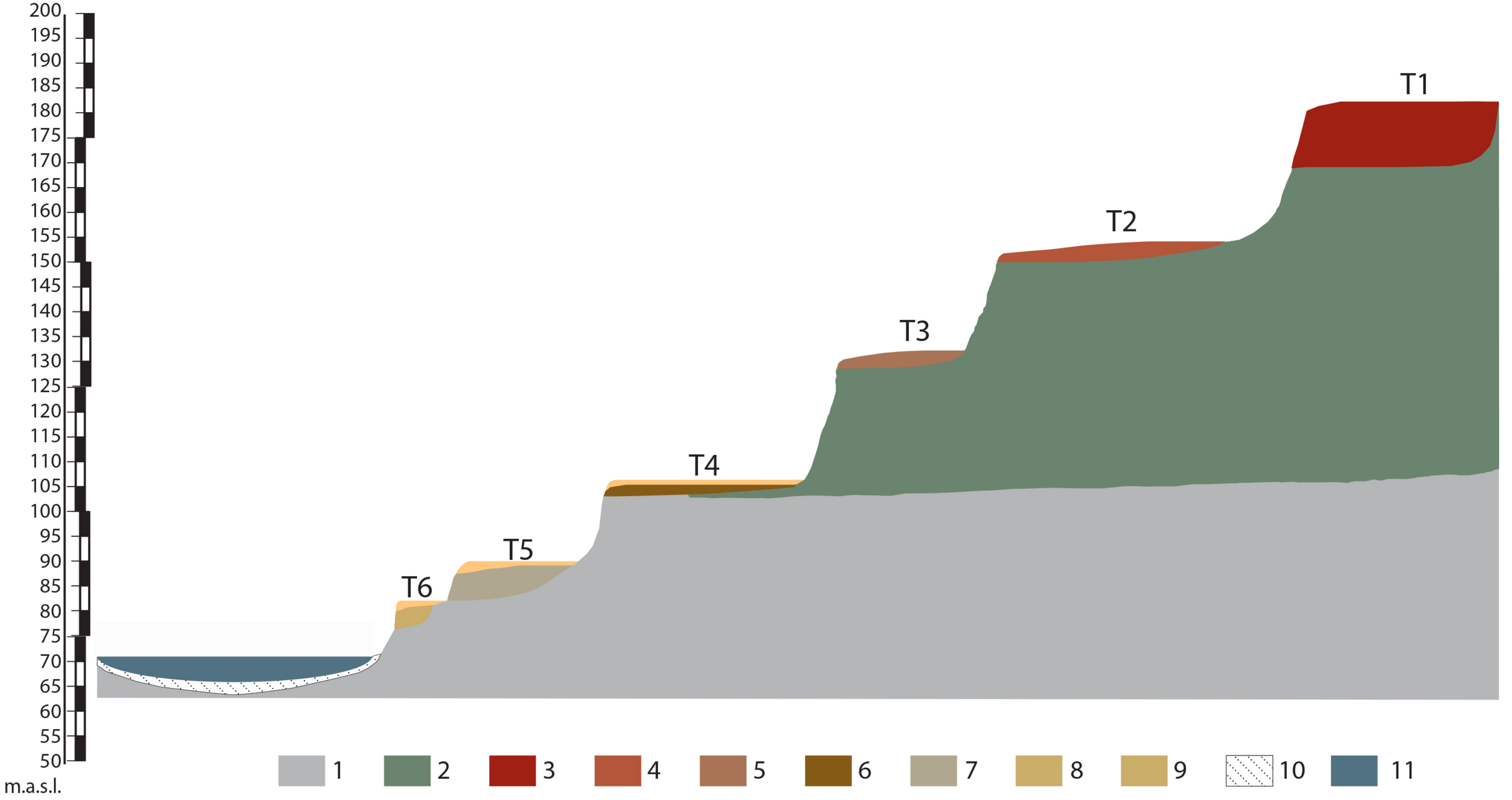
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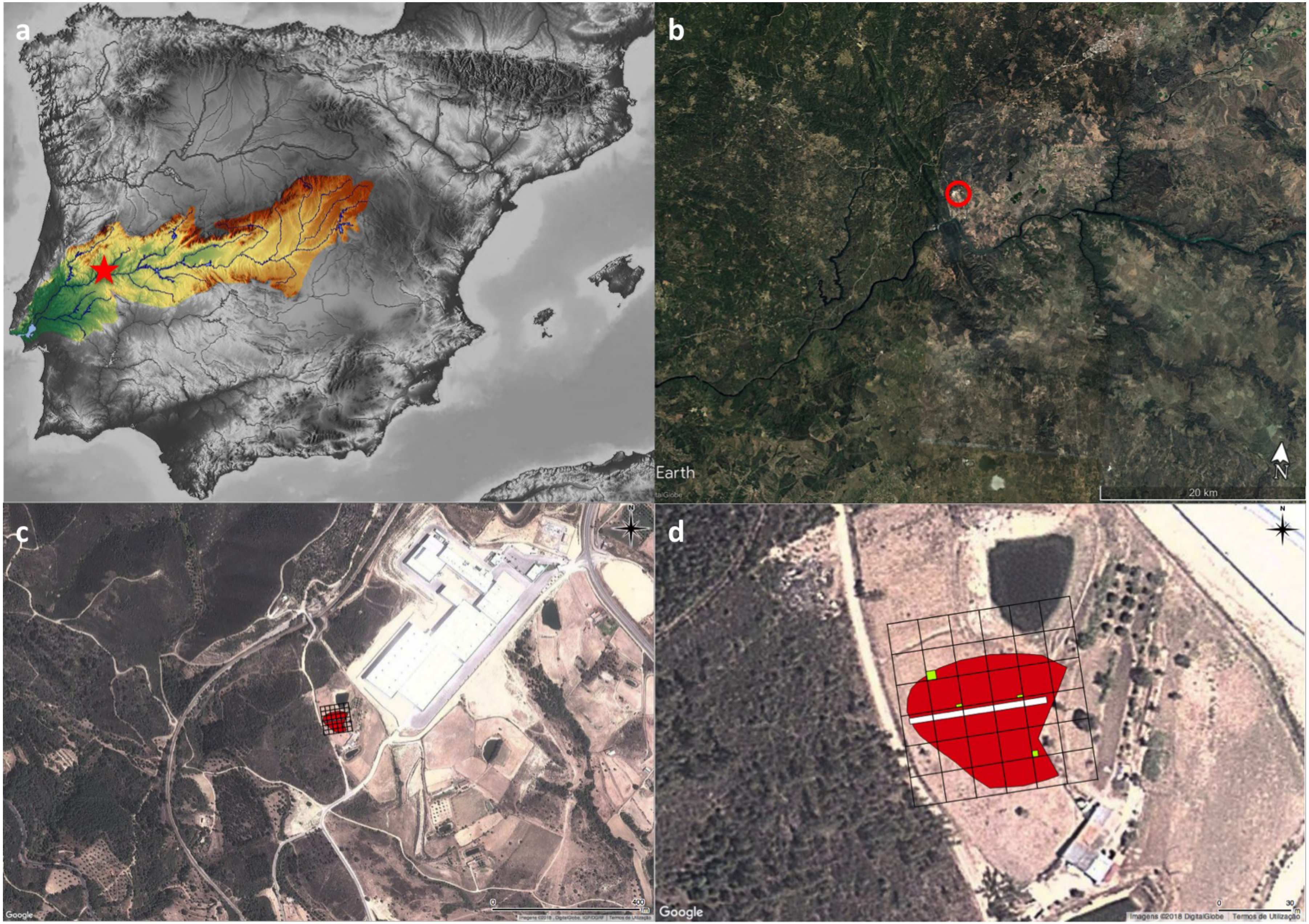
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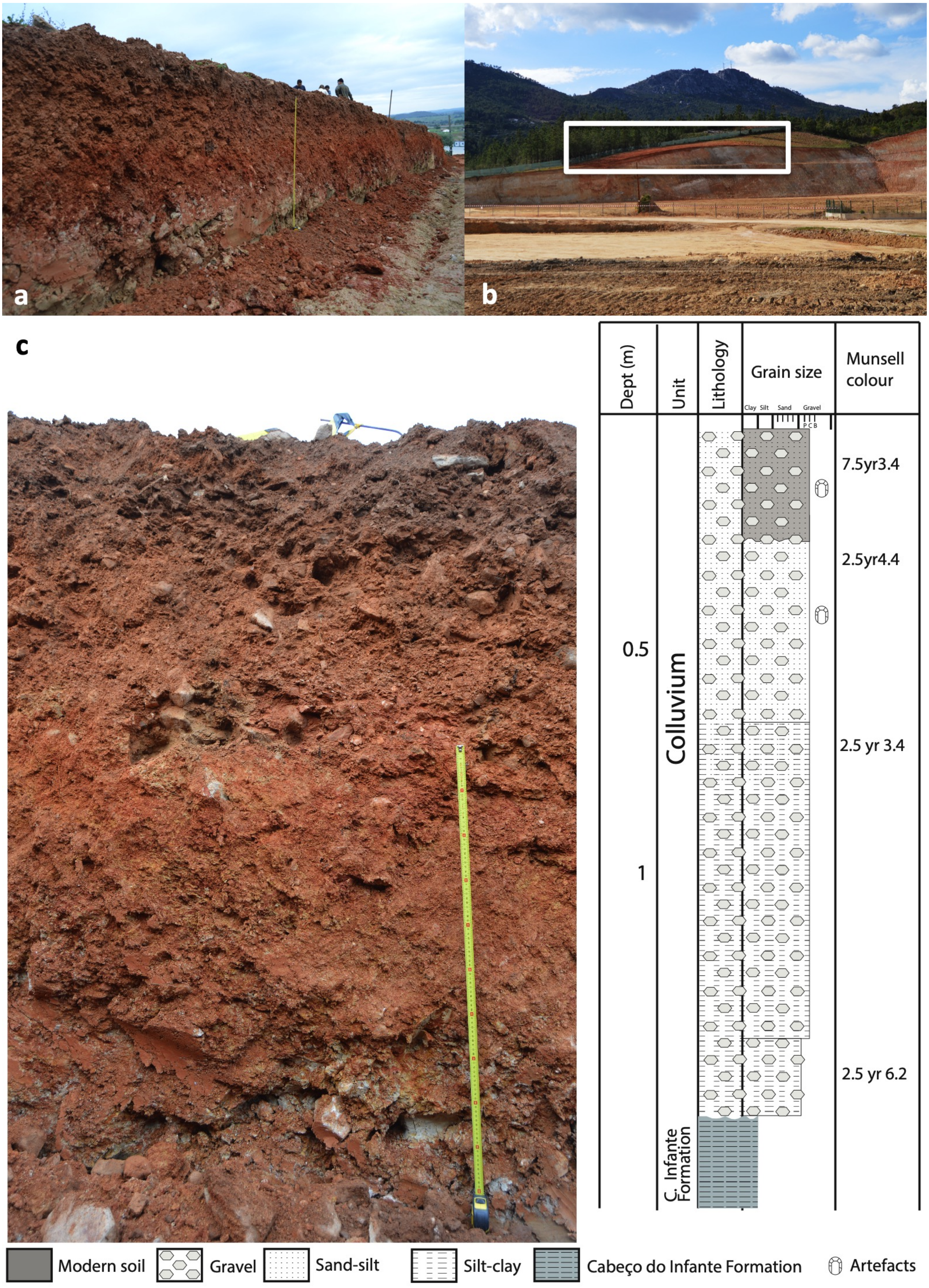
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Unit
Lithology
Grain size
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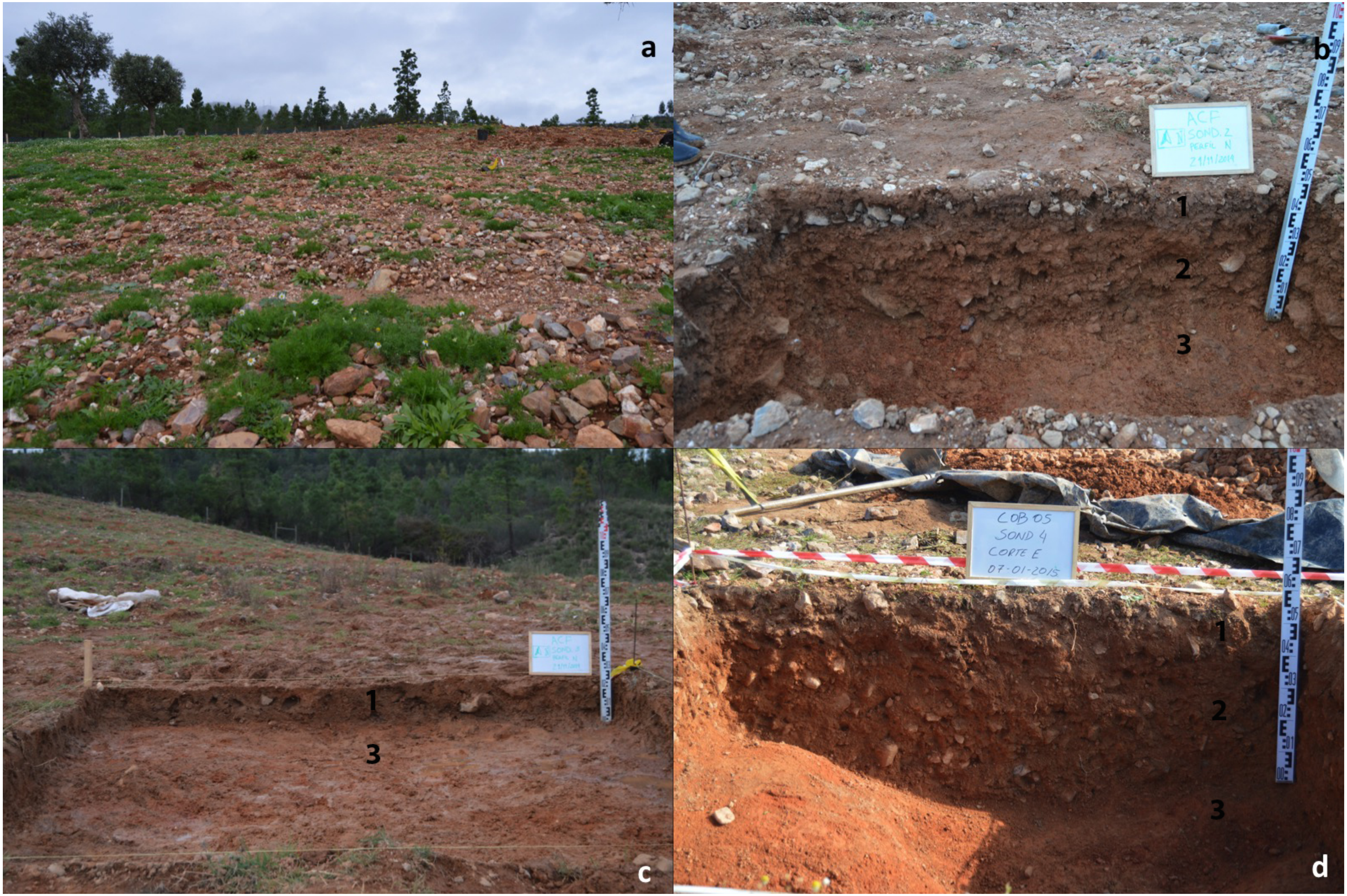
Colluvium
C. Infante Formation
7.5yr3.4
2.5yr4.4
2.5 yr 3.4
2.5 yr 6.2
Modern soil
Gravel
Sand-silt
Silt-clay
Cabeço do Infante Formation
Artefacts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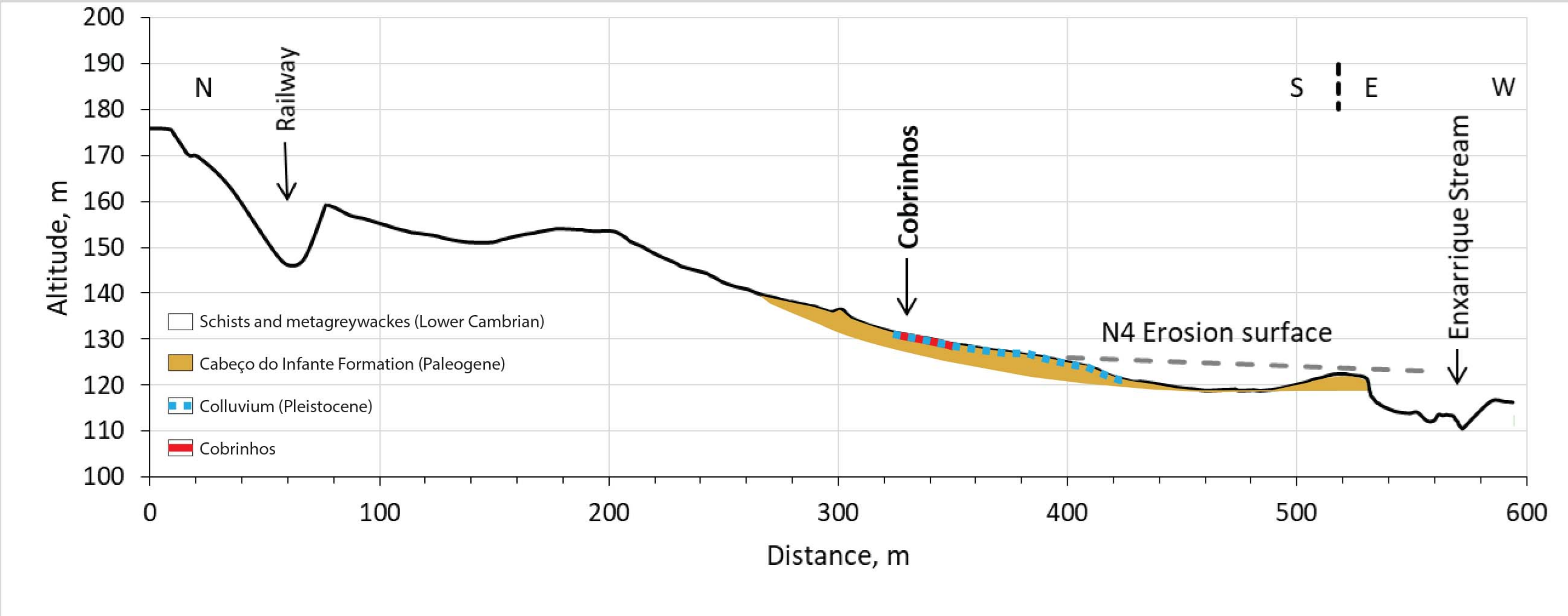
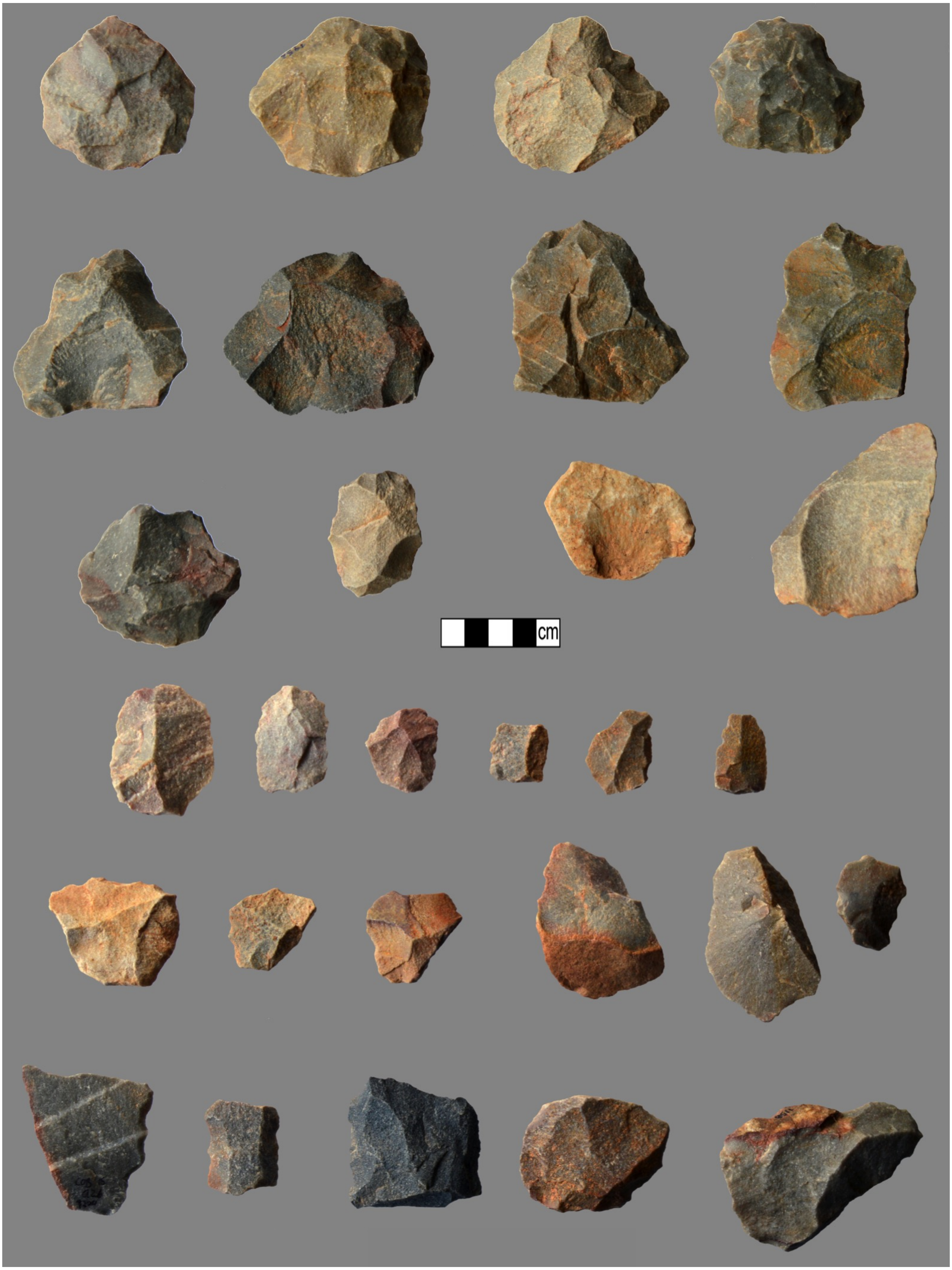


Altitude, m
200
190
180
170
160
150
140
130
120
110
100
N
Railway
S
E
W
Cobrinhos
Enxarrique Stream
N4 Erosion surface
Schists and metagreywackes (Lower Cambrian)
Cabeço do Infante Formation (Paleogene)
Colluvium (Pleistocene)
Cobrinhos
0
100
200
300
400
500
600
Distance, m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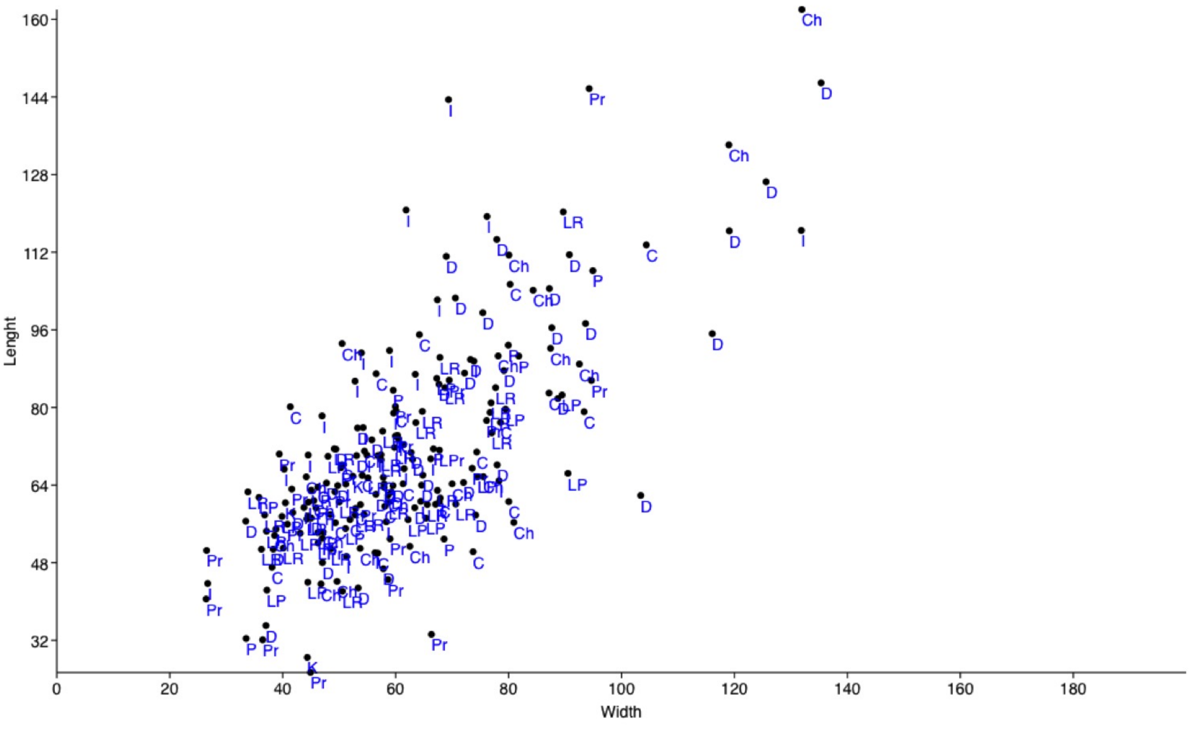
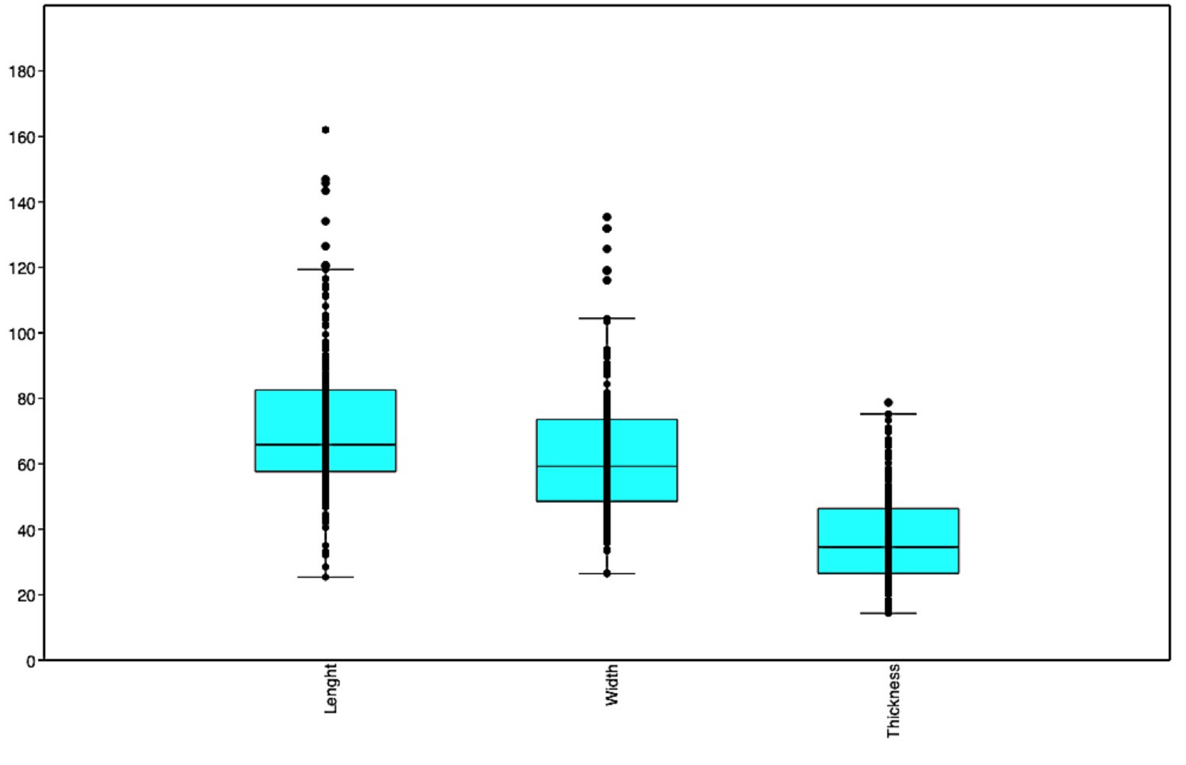
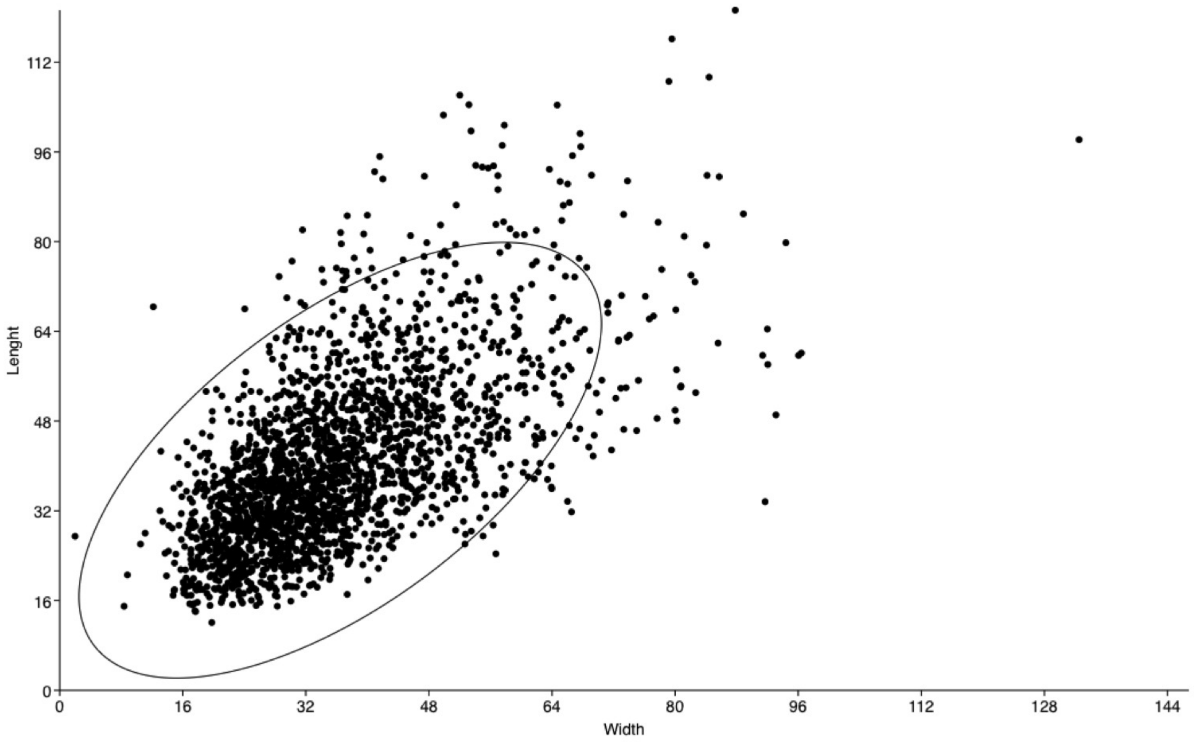




b



Lenght
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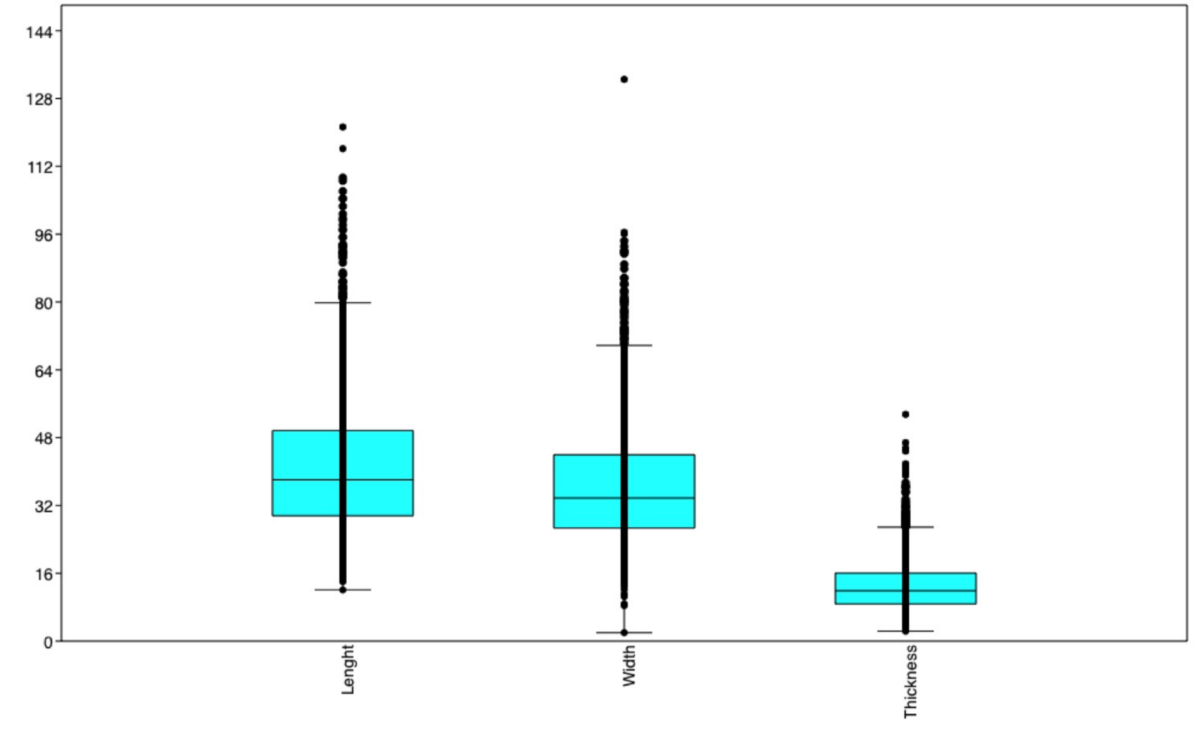
a



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Supplementary information

Table 1: Summary of key geological, geomorphological and archaeological attributes for the culminant sedimentary unit and terrace sequences represented at the reach Ia (Vila Velha de Ródão) with indication of the probable age and elevation above river bed of each surface.

Sedimentary unit (Lower Tejo)	Iberian system	Typology	m.a.s.l.	m.a.r.b.	Tickness (m)	Era/Period	Age	Sediments	Archaeological finds	Archaeological sites
Falagueira Formation		Culminant sedimentary unit (ancestral Tejo, before the drainage network entrenchment)	210	138	10	Pliocene; Early Pleistocene (Placencean-Gelasiane)	Probable age 3.7 - 1.8 Ma	- Yellowish to white quartz rich sands with grey intercalations - Poorly to moderate sorted clast-supported boulder gravels of quartzite (ca. 80%) and milky quartz (ca. 20%); - Maximum Pebble Size =32 cm	Without artifacts	
T1	T16	Depositional terrace	183	111	13	Early Pleistocene (Calabrian)	Probable age 1 Ma - 900 ka	- Red clay with coarse quartz sands - Poorly to moderate sorted massive clast-supported gravel–boulder conglomerates. Sub-rounded to rounded clasts of quartzite (76-90%) and milky quartz (14-10%) - Maximum Pebble Size =32 cm	Without artifacts	
T2	T17	Depositional terrace	155	83	4	Middle Pleistocene	Top: Probable age 600 ka	- Brown redish clay with coarse quartz sands - Poorly sorted massive clast-supported gravel–boulder conglomerates. -Sub-rounded to rounded clasts of quartzite (69-80%) and milky quartz (31-20%); Maximum Pebble Size =30 cm	Without artifacts	
T3	T18	Depositional terrace	133	61	4	Middle Pleistocene	460-360 (?) ka	- Brown redish to red clay soil with coarse quartz sands - 0.5 m-thick poorly sorted coarse sandstone lenses - Poorly to moderate sorted massive clast-supported gravel–boulder conglomerates, -Sub-rounded to rounded clasts of quartzite (78-44%) and milky quartz (66-22%); Maximum Pebble Size =24 cm	Without artifacts	
T4	T19	Depositional terrace	106	34	1-2	Middle-Upper Pleistocene	ca. 340-155 ka	- Brown redish clays composed of Ilite (Iks), vermiculite (Vki), caulinite (Kis) esmectite e caulinite (SKi). A with medium to coarse sands - Poorly to moderate sorted massive clast-supported gravel–boulder conglomerates -Sub-rounded clasts of quartzite (75-66%),	Basal levels: Lower Palaeolithic (Acheulean) --------------------- Middle levels: Lower Palaeolithic (Acheulean) ---------------------	Milharós, Campo de Futebol da Atalaia, Pegos do Tejo 2

								milky quartz (44-25%) and rare slates of metagreywackes; Maximum Pebble Size =32 cm	Upper levels: Middle Palaeolithic (Mousterian)	
T5	T20	Depositional terrace	90	18	8	Upper Pleistocene	135-73 ka	Base: Not exposed Top: Green to grey coarse to very fine sands with some pedogenic calcareous concretions.	Top to Base: Middle Palaeolithic (Mousterian)	Caminho da Celulose, Vilas Ruivas, Ribeira da Atalaia -T5 top,
T6	T21	Depositional terrace	82	10	6	Upper Pleistocene	62-32 ka	- Base: 0.5 m-thich Poorly to moderate sorted massive clast-supported gravel-boulder conglomerates of quartzite, milky quartz and metagreywacke slates - Above the base: Yellow to green fine sandy-silts with some pedogenic calcareous concretions; -Sub-rounded clasts of quartzite and slates/metagreywackes; Maximum Pebble Size =31 cm;	Top to Base: Middle Palaeolithic (Mousterian)	Estrada do Prado, Santa Cita, Conceição, Santo. Antão do Tojal, Campo de Futebol de Santo Antão do Tojal, Azinhal, Tapada do Montinho, Foz do Enxarrique
Carregueira Formation	Aeolean sands	Aeolian cover unit	Variable	Variable	<1	Early to Middle Holocene	32-12 ka	- Very fine moderately sorted yellowish to white sands	Top to Base: Upper Palaeolithic and Epipalaeolithic	Vilas Ruivas, Monte da Revelada, Alto da Revelada, Rio Maior Upper Palaeolithic sites, Santa Cita
Aluvial plain	Aluvial plain	Modern alluvium	72	<1	0-4	Late Holocene	12 ka-present	-Pebbly to boulder sands and gravels		

Lithic assemblage

Table 2: Cobrinhos. Core assemblage.

Core feature/raw material		Quartzite	Black quartzite	Quartz	Total
Core type	Choppping/Chopping-tool	24			24
	Centripetal	23	1	1	25
	Discoidal	42	3	1	46
	Informal	34	1		35
	Levallois preferential	15	3		18
	Levallois recurrent	31	2		33
	Polyhedral	5	2		7
	Prismatic	16	2	3	21
	Kombewa	3	1		4
	Total	**193**	**15**	**5**	**213**
Cortex%	**Choppping/Chopping-tool**	**11.3**	**0.0**	**0.0**	**11.3**
	0%	4.7	0.0	0.0	4.7
	1-30%	3.3	0.0	0.0	3.3
	31-60%	1.9	0.0	0.0	1.9
	61-99%	1.4	0.0	0.0	1.4
	Centripetal	**10.8**	**0.5**	**0.5**	**11.7**
	0%	7.0	0.5	0.5	8.0
	1-30%	1.9	0.0	0.0	1.9
	31-60%	1.4	0.0	0.0	1.4
	61-99%	0.5	0.0	0.0	0.5
	Discoidal	**19.7**	**1.4**	**0.5**	**21.6**
	0%	8.4	0.5	0.5	9.4
	1-30%	8.9	0.5	0.0	9.4
	31-60%	1.9	0.0	0.0	1.9
	61-99%	0.5	0.5	0.0	0.9
	Informal	**16.0**	**0.5**	**0.0**	**16.4**
	0%	7.5	0.5	0.0	8.0
	1-30%	4.7	0.0	0.0	4.7
	31-60%	2.8	0.0	0.0	2.8
	61-99%	0.9	0.0	0.0	0.9
	Levallois_preferencial	**7.0**	**1.4**	**0.0**	**8.4**
	0%	4.2	0.9	0.0	5.2
	1-30%	2.3	0.5	0.0	2.8
	31-60%	0.5	0.0	0.0	0.5
	Levallois_recurrent	**14.5**	**0.9**	**0.0**	**15.5**
	0%	11.3	0.5	0.0	11.7
	1-30%	2.3	0.5	0.0	2.8
	31-60%	0.9	0.0	0.0	0.9
	Polyhedral	**2.3**	**0.9**	**0.0**	**3.3**
	0%	0.5	0.0	0.0	0.5
	1-30%	1.4	0.0	0.0	1.4
	31-60%	0.5	0.9	0.0	1.4
	Prismatic	**7.5**	**0.9**	**1.4**	**9.9**
	0%	2.3	0.5	0.9	3.8

	1-30%	2.3	0.5	0.5	3.3
	31-60%	1.4	0.0	0.0	1.4
	61-99%	1.4	0.0	0.0	1.4
	Kombewa	**1.4**	**0.5**	**0.0**	**1.9**
	1-30%	0.9	0.5	0.0	1.4
	31-60%	0.5	0.0	0.0	0.5
	Total	**90.6**	**7.0**	**2.3**	**100.0**
Abandonement		**90.6**	**7.0**	**2.3**	**100.0**
	Chopping/Chopping-tool	**11.3**	**0.0**	**0.0**	**11.3**
	Simple abandonment	8.4	0.0	0.0	8.4
	Raw material problem	0.9	0.0	0.0	0.9
	Lost of volume	1.9	0.0	0.0	1.9
	Centripetal	**10.8**	**0.5**	**0.5**	**11.7**
	Simple abandonment	8.4	0.5	0.5	9.4
	Raw material problem	1.9	0.0	0.0	1.9
	Lost of volume	0.5	0.0	0.0	0.5
	Discoidal	**19.7**	**1.4**	**0.5**	**21.6**
	Simple abandonment	13.1	0.9	0.5	14.5
	Raw material problem	1.9	0.0	0.0	1.9
	Knapping problem	0.5	0.0	0.0	0.5
	Lost of volume	4.2	0.5	0.0	4.7
	Informal	**16.0**	**0.5**	**0.0**	**16.4**
	Simple abandonment	8.0	0.0	0.0	8.0
	Raw material problem	0.0	0.5	0.0	0.5
	Knapping problem	7.0	0.0	0.0	7.0
	Lost of volume	0.9	0.0	0.0	0.9
	Levallois preferential	**7.0**	**1.4**	**0.0**	**8.4**
	Simple abandonment	5.6	0.5	0.0	6.10
	Raw material problem	0.5	0.0	0.0	0.5
	Knapping problem	0.5	0.5	0.0	0.9
	Lost of volume	0.5	0.5	0.0	0.9
	Levallois recurrent	**14.5**	**0.9**	**0.0**	**15.5**
	Simple abandonment	8.4	0.5	0.0	8.9
	Raw material problem	1.9	0.0	0.0	1.9
	Lost of volume	4.2	0.5	0.0	4.7
	Polyhedral	**2.3**	**0.9**	**0.0**	**3.3**
	Simple abandonment	1.9	0.9	0.0	2.8
	Lost of volume	0.5	0.0	0.0	0.5
	Prismatic	**7.5**	**0.9**	**1.4**	**9.9**
	Simple abandonment	6.10	0.5	0.9	7.5
	Raw material problem	0.0	0.0	0.5	0.5
	Knapping problem	0.5	0.5	0.0	0.9
	Lost of volume	0.9	0.0	0.0	0.9
	Kombewa	**1.4**	**0.5**	**0.0**	**1.9**
	Simple abandonment	0.9	0.5	0.0	1.4
	Lost of volume	0.5	0.0	0.0	0.5
	Total	**90.6**	**7.0**	**2.3**	**100.0**

Table 3: Cobrinhos. Blank assemblage.

Blank feature/raw material		Greywacke	Quartzite	Black quartzite	Quartz	Flint	Total
Fraction	**Blade**	**0.0**	**1.7**	**0.10**	**0.0**	**0.0**	**1.8**
	Distal	0.0	0.2	0.0	0.0	0.0	0.3
	Complete	0.0	1.2	0.1	0.0	0.0	1.3
	Proximal	0.0	0.2	0.0	0.0	0.0	0.2
	Flake	**0.0**	**84.0**	**12.0**	**1.6**	**0.0**	**97.6**
	Distal	0.0	7.5	1.2	0.0	0.0	8.7
	Complete	0.0	64.4	8.2	1.3	0.0	73.9
	Lateral	0.0	5.8	1.4	0.2	0.0	7.4
	Mesial	0.0	0.8	0.2	0.1	0.0	1.1
	Proximal	0.0	5.6	0.9	0.0	0.0	6.5
	Point	**0.0**	**0.4**	**0.1**	**0.0**	**0.0**	**0.5**
	Complete	0.0	0.4	0.1	0.0	0.0	0.5
	Proximal	0.0	0.0	0.0	0.0	0.0	0.0
	Total	**0.0**	**86.2**	**12.1**	**1.6**	**0.0**	**100.0**
Cortex %	**Blade**	**0.0**	**1.7**	**0.10**	**0.0**	**0.0**	**1.8**
	0	0.0	1.0	0.1	0.0	0.0	1.1
	1-30	0.0	0.2	0.0	0.0	0.0	0.2
	100	0.0	0.1	0.0	0.0	0.0	0.1
	31-60	0.0	0.3	0.0	0.0	0.0	0.3
	61-99	0.0	0.1	0.0	0.0	0.0	0.2
	Flake	**0.0**	**84.0**	**12.0**	**1.6**	**0.0**	**97.6**
	0	0.0	53.6	8.4	1.3	0.0	63.3
	1-30	0.0	14.2	1.9	0.1	0.0	16.2
	100	0.0	6.5	0.7	0.1	0.0	7.3
	31-60	0.0	5.2	0.4	0.0	0.0	5.6
	61-99	0.0	4.6	0.5	0.0	0.0	5.1
	Point	**0.0**	**0.4**	**0.1**	**0.0**	**0.0**	**0.5**
	0	0.0	0.4	0.1	0.0	0.0	0.4
	1-30	0.0	0.1	0.0	0.0	0.0	0.1
	Total	**0.0**	**86.2**	**12.1**	**1.6**	**0.0**	**100.0**
Cortex location	**Blade**	0.0	**2.2**	**0.1**	**0.0**	0.0	**2.4**
	Central	0.0	0.1	0.0	0.0	0.0	0.1
	Distal	0.0	0.2	0.0	0.0	0.0	0.2
	Lateral	0.0	1.1	0.1	0.0	0.0	1.2
	Lateral and distal	0.0	0.4	0.0	0.0	0.0	0.4
	Lateral and proximal	0.0	0.4	0.0	0.0	0.0	0.4
	Flake	0.0	**86.5**	**10.4**	**0.5**	0.0	**97.4**
	Central	0.0	2.5	0.2	0.0	0.0	2.7
	Distal	0.0	21.6	2.1	0.1	0.0	23.9
	Lateral	0.0	21.9	3.4	0.0	0.0	25.3
	Lateral and distal	0.0	17.6	1.6	0.1	0.0	19.4
	Lateral and proximal	0.0	15.1	1.9	0.2	0.0	17.3

	Mesial	0.0	0.6	0.2	0.0	0.0	0.9
	Proximal	0.0	7.0	0.9	0.0	0.0	7.9
	Point	0.0	**0.2**	**0.0**	**0.0**	0.0	**0.2**
	Lateral and distal	0.0	0.2	0.0	0.0	0.0	0.2
	Total	**0.0**	**89.0**	**10.5**	**0.5**	**0.0**	**100.0**
Section	**Blade**	**0.0**	**1.6**	**0.1**	**0.0**	**0.0**	**1.7**
	Convex	0.0	0.1	0.0	0.0	0.0	0.1
	Irregular	0.0	0.2	0.0	0.0	0.0	0.2
	Plain	0.0	0.1	0.0	0.0	0.0	0.1
	Trapezoidal	0.0	0.2	0.0	0.0	0.0	0.2
	Triangular	0.0	1.0	0.1	0.0	0.0	1.1
	Flake	**0.0**	**85.1**	**10.8**	**1.7**	**0.0**	**97.6**
	Convex	0.0	2.9	0.7	0.0	0.0	3.6
	Irregular	0.0	13.5	1.4	0.4	0.0	15.4
	Plain	0.0	25.6	2.6	0.6	0.0	28.8
	Trapezoidal	0.0	13.0	2.1	0.2	0.0	15.3
	Triangular	0.0	30.2	3.9	0.5	0.0	34.6
	Point	**0.0**	**0.5**	**0.1**	**0.0**	**0.0**	**0.6**
	Plain	0.0	0.1	0.0	0.0	0.0	0.1
	Trapezoidal	0.0	0.0	0.1	0.0	0.0	0.1
	Triangular	0.0	0.4	0.0	0.0	0.0	0.4
	Total	**0.0**	**87.3**	**11.0**	**1.7**	**0.0**	**100.0**
Edges	**Blade**	**0.0**	**1.6**	**0.1**	**0.0**	**0.0**	**1.7**
	Biconcave	0.0	0.0	0.0	0.0	0.0	0.0
	Biconvex	0.0	0.3	0.0	0.0	0.0	0.3
	Concave Convex	0.0	0.4	0.0	0.0	0.0	0.5
	Convergent	0.0	0.1	0.0	0.0	0.0	0.1
	Divergent	0.0	0.1	0.0	0.0	0.0	0.1
	Irregular	0.0	0.2	0.0	0.0	0.0	0.2
	Parallel	0.0	0.4	0.0	0.0	0.0	0.5
	Flake	**0.0**	**85.1**	**10.8**	**1.7**	**0.0**	**97.6**
	Biconcave	0.0	1.7	0.2	0.1	0.0	1.9
	Biconvex	0.0	17.6	1.3	0.4	0.0	19.3
	Concave Convex	0.0	16.5	1.8	0.3	0.0	18.7
	Convergent	0.0	3.0	0.6	0.0	0.0	3.7
	Divergent	0.0	11.1	2.4	0.0	0.0	13.6
	Irregular	0.0	30.6	3.6	0.8	0.0	34.9
	Parallel	0.0	4.6	0.9	0.0	0.0	5.5
	Point	**0.0**	**0.5**	**0.1**	**0.0**	**0.0**	**0.6**
	Biconvex	0.0	0.2	0.0	0.0	0.0	0.3
	Convergent	0.0	0.3	0.0	0.0	0.0	0.3
	Irregular	0.0	0.0	0.0	0.0	0.0	0.0
	Total	**0.0**	**87.2**	**11.0**	**1.7**	**0.0**	**100.0**
Profile	**Blade**	**0.0**	**1.6**	**0.1**	**0.0**	**0.0**	**1.7**
	Curved	0.0	0.2	0.0	0.0	0.0	0.3
	Straight	0.0	1.4	0.0	0.0	0.0	1.4
	Twisted	0.0	0.0	0.0	0.0	0.0	0.0
	Flake	**0.0**	**85.1**	**10.8**	**1.7**	**0.0**	**97.6**

	Curved	0.0	14.6	2.1	0.2	0.0	16.9
	Straight	0.0	64.8	8.1	1.3	0.0	74.3
	Twisted	0.0	3.7	0.3	0.2	0.0	4.2
	Point	0.0	1.9	0.3	0.0	0.0	2.3
	Curved	**0.0**	**0.5**	**0.1**	**0.0**	**0.0**	**0.6**
	Straight	0.0	0.1	0.0	0.0	0.0	0.1
	Total	0.0	0.4	0.1	0.0	0.0	0.5
Dorsal patterns	**Blade**	**1.6**	**0.1**	**0.0**	**0.0**	**1.7**	**1.6**
	Bidirectional	0.2	0.0	0.0	0.0	0.2	0.2
	Centripetal	0.1	0.0	0.0	0.0	0.1	0.1
	Cortical	0.1	0.0	0.0	0.0	0.1	0.1
	Crossed	0.0	0.0	0.0	0.0	0.0	0.0
	Opposed	0.3	0.0	0.0	0.0	0.3	0.3
	Unidirectional	0.6	0.0	0.0	0.0	0.7	0.6
	Unidirectional convergent	0.2	0.0	0.0	0.0	0.3	0.2
	Flake	**85.1**	**10.8**	**1.7**	**0.0**	**97.6**	**85.1**
	Bidirectional	2.4	0.5	0.0	0.0	2.9	2.4
	Bulb	0.4	0.0	0.0	0.0	0.4	0.4
	Centripetal	8.9	1.8	0.0	0.0	10.7	8.9
	Cortical	7.9	0.9	0.1	0.0	8.9	7.9
	Crossed	27.9	3.4	0.4	0.0	31.8	27.9
	Opposed convergent	0.5	0.0	0.0	0.0	0.5	0.5
	Opposed	6.2	0.8	0.2	0.0	7.2	6.2
	Unidirectional	28.9	3.3	0.8	0.0	33.00	28.9
	Unidirectional convergent	1.9	0.1	0.0	0.0	2.1	1.9
	Point	**0.5**	**0.1**	**0.0**	**0.0**	**0.6**	**0.5**
	Bidirectional	0.0	0.0	0.0	0.0	0.0	0.0
	Centripetal	0.0	0.0	0.0	0.0	0.0	0.0
	Crossed	0.1	0.0	0.0	0.0	0.2	0.1
	Opposed convergent	0.1	0.0	0.0	0.0	0.1	0.1
	Unidirectional	0.1	0.0	0.0	0.0	0.1	0.1
	Unidirectional convergent	0.1	0.0	0.0	0.0	0.1	0.1
	Total	**87.3**	**10.9**	**1.7**	**0.0**	**100.0**	**87.3**
Distal end	**Blade**	**0.0**	**1.6**	**0.1**	**0.0**	**0.0**	**1.7**
	Pointed	0.0	0.1	0.0	0.0	0.0	0.1
	Burinated	0.0	0.1	0.0	0.0	0.0	0.1
	Stepped	0.0	0.4	0.0	0.0	0.0	0.4
	Feathered	0.0	0.4	0.1	0.0	0.0	0.5
	Thick	0.0	0.1	0.0	0.0	0.0	0.1
	Fractured	0.0	0.1	0.0	0.0	0.0	0.1
	Reflected	0.0	0.0	0.0	0.0	0.0	0.0
	Hinged	0.0	0.3	0.0	0.0	0.0	0.3
	Retouched	0.0	0.0	0.0	0.0	0.0	0.0
	Overpassed	0.0	0.0	0.0	0.0	0.0	0.0
	Flake	**0.0**	**85.1**	**10.8**	**1.7**	**0.0**	**97.6**

	Pointed	0.0	2.2	0.1	0.1	0.0	2.4
	Burinated	0.0	1.5	0.4	0.0	0.0	1.9
	Stepped	0.0	25.8	2.8	0.5	0.0	29.2
	Feathered	0.0	24.7	3.4	0.4	0.0	28.5
	Thick	0.0	3.6	0.6	0.0	0.0	4.3
	Fractured	0.0	3.2	0.4	0.2	0.0	3.8
	Reflected	0.0	0.0	0.0	0.0	0.0	0.0
	Hinged	0.0	18.2	1.8	0.3	0.0	20.4
	Retouched	0.0	2.5	0.7	0.0	0.0	3.3
	Overpassed	0.0	3.2	0.6	0.0	0.0	3.8
	Point	**0.0**	**0.5**	**0.1**	**0.0**	**0.0**	**0.6**
	Pointed	0.0	0.5	0.0	0.0	0.0	0.5
	Hinged	0.0	0.0	0.0	0.0	0.0	0.0
	Retouched	0.0	0.0	0.0	0.0	0.0	0.0
	Total	**0.0**	**87.2**	**11.0**	**1.7**	**0.0**	**100.0**
Platform	**Blade**	**1.8**	**0.1**	**0.0**	**0.0**	**1.9**	**1.8**
	Cortical	0.1	0.0	0.0	0.0	0.1	0.1
	Dihedral	0.2	0.0	0.0	0.0	0.2	0.2
	Faceted	0.3	0.0	0.0	0.0	0.3	0.3
	Linear	0.1	0.0	0.0	0.0	0.1	0.1
	Plain	1.0	0.0	0.0	0.0	1.1	1.0
	Punctate	0.1	0.0	0.0	0.0	0.1	0.1
	Flake	**84.9**	**11.0**	**1.5**	**0.0**	**97.5**	**84.9**
	Cortical	10.0	1.3	0.1	0.0	11.4	10.0
	Dihedral	11.3	1.5	0.2	0.0	13.0	11.3
	Smashed	3.2	0.2	0.2	0.0	3.6	3.2
	Faceted	10.2	1.9	0.1	0.0	12.2	10.2
	Linear	3.1	0.6	0.0	0.0	3.8	3.1
	Plain	42.8	45.0	0.9	0.0	48.7	42.8
	Punctate	4.10	0.5	0.1	0.0	4.7	4.10
	Point	**0.5**	**0.1**	**0.0**	**0.0**	**0.6**	**0.5**
	Cortical	0.0	0.0	0.0	0.0	0.0	0.0
	Faceted	0.2	0.0	0.0	0.0	0.2	0.2
	Plain	0.3	0.0	0.0	0.0	0.4	0.3
	Total	**87.2**	**11.2**	**1.5**	**0.0**	**100.0**	**87.2**

Table 4: Distribution of the total lithic assemblage and of the m3 excavated.

Area	**I28**	**I26**	**I24**	**F26**	**G26**	**J25**	**I27**	**E27**	**F24**	**E25**	**H24**	**G25**	**F27**	**G27**	**F25**	**H28**	**G24**	**G27**	**G28**	**I25**	**H27**	**H25**	**Surface**	**Trench**	**Total**
Artefacts	11	28	50	76	76	102	286	306	402	430	471	601	603	604	691	953	1166	1421	1454	1485	1659	1695	478	731	15779
m^3	n/d	n/d	n/d	n/d	n/d	n/d	n/d	36	27	18	18	18	36	63	18	36	27	63	54	36	27	45	n/d	153	675
Artefacts/m^3								8,5	14,9	23,9	26,2	33,4	16,8	9,6	38,4	26,5	43,2	22,6	26,9	41,3	61,4	37,7		4,8	23,4